

PCT

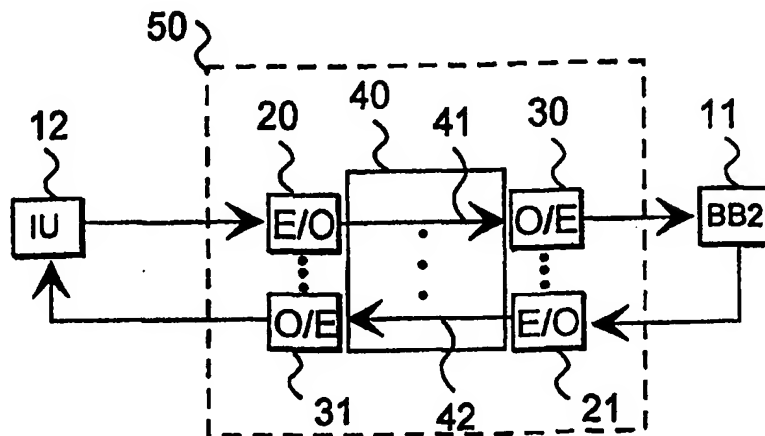
WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H04B 10/12, G06F 1/10		A1	(11) International Publication Number: WO 99/59270
			(43) International Publication Date: 18 November 1999 (18.11.99)
(21) International Application Number: PCT/FI99/00389 (22) International Filing Date: 10 May 1999 (10.05.99) (30) Priority Data: 981079 14 May 1998 (14.05.98) FI (71) Applicant (for all designated States except US): NOKIA NETWORKS OY [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI). (72) Inventor; and (75) Inventor/Applicant (for US only): MARJAKANGAS, Jari [FI/FI]; Neulastie 7, FIN-90800 Oulu (FI). (74) Agent: PATENTTITOIMISTO TEKNOPOLOIS KOLSTER OY; c/o Kolster Oy AB, Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).		(81) Designated States: AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>	

(54) Title: **SIGNAL TRANSMISSION METHOD AND MOTHERBOARD STRUCTURE**



(57) Abstract

The invention relates to a signal transmission method and a motherboard structure (50) used in a base station of a radio system, for example, and comprises printed circuit board units (10-12) communicating with the motherboard structure and communicating with one another by signals. The motherboard structure (50) comprises an optical fibre sheet (40) having optical fibres (41, 42) arranged therein, first converter means (20, 21) receiving from the printed circuit board unit electrical low-power and high-frequency signals, such as clock signals and RF signals. The first converter means convert the received signals into optical signals, and each optical signal is conducted into an optical fibre of its own in the fibre sheet (40). The motherboard structure further comprises second converter means (30, 31) converting the optical signals which have propagated in the fibre sheet (40) back into electrical signals which are conducted to the printed circuit board units after the conversion.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

SIGNAL TRANSMISSION METHOD AND MOTHERBOARD STRUCTURE

FIELD OF THE INVENTION

The present invention relates to a signal transmission method used in a base station of a radio system, for example, the base station being composed of a motherboard structure and printed circuit board units transmitting signals to one another.

BACKGROUND OF THE INVENTION

In prior art motherboard structures, units coupled to the motherboard structure communicate with one another by signals transmitted and received by the units. Generally, extremely high-frequency signals, such as clock signals, which enable, for example, different units to be synchronized with one another, are transmitted through a motherboard structure. In addition, the units transmit RF signals to other units through a motherboard. Frequencies of high-frequency clock signals are reduced before they are transmitted to the motherboard, after which the clock frequency is again raised to the original value. However, changing the clock frequency to and fro may have caused frequency changes to the clock signal frequency.

Since a large number of different signals is transmitted through the motherboard, much wiring is needed thereon. However, space on the motherboard is restricted, for which reason designing the motherboard has become problematic. This inevitably results in dense wiring, and therefore signals transmitted along the wiring interfere, at least to some extent, with one another.

The aim has been to alleviate the above problems by conducting interfering signals to separate cables by which the motherboard is passed. However, in practice it is difficult and relatively expensive to use the cables. If separate cables have to be used frequently, signals to be transmitted along the cables also generate different types of interference. Furthermore, transmission capacity of long cables is not adequate enough for all applications. It has also been problematic to use the cables because of faulty couplings made at the installation stage of the cables and cracking of the cable insulating material at low temperatures.

BRIEF DESCRIPTION OF THE INVENTION

An object of the invention is thus to provide a method and a motherboard structure to solve the above problems. This is achieved by a method of the type presented in the introduction, which is characterized by when the printed circuit board units of the base station communicate with one another by signals which are transmitted through the common motherboard structure, of these signals converting into optical signals those with a low power and a high frequency, such as clock signals and RF signals and conducting each optical signal into an optical fibre of its own, each optical fibre being placed inside a fibre sheet attached to the motherboard structure, converting the optical signals that have propagated in the fibre sheet back into electrical signals and conducting each signal that has been converted into an electrical signal to the printed circuit board unit.

The invention also relates to a motherboard structure used in a base station of a radio system, for example, and comprises printed circuit board units communicating with the motherboard structure, the printed circuit board units communicating with one another by signals.

The motherboard structure of the invention is characterized in that the motherboard structure comprises an optical fibre sheet with optical fibres arranged therein, first converter means receiving from the printed circuit board units electrical low-power and high-frequency signals, such as clock signals and RF signals, and converting the received signals into optical signals, each optical signal being conducted into an optical fibre of its own in the fibre sheet, and second converter means converting the optical signals that have propagated in the fibre sheet back into electrical signals which are conducted to the printed circuit board units after the conversion.

The preferred embodiments of the invention are disclosed in the dependent claims.

The invention is based on the idea of using a fibre sheet in the motherboard structure of a base station and transmitting in the fibre sheet signals between the units arranged in the base station, which makes it possible to prevent the signals transmitted through the motherboard from causing interference on the motherboard.

The method and motherboard structure of the invention provide many advantages. An optical fibre sheet arranged in the motherboard enables the generation of electromagnetic interference, for example, to be reduced on

the motherboard. When signals which probably generate interference are transmitted on the fibre sheet, the rest of the motherboard structure can be simplified. The use of the fibre sheet enables the layers of the printed circuit board to be reduced, which makes it easier and faster to design the motherboard. Furthermore, thanks to fewer layers on the printed circuit board, the manufacturing costs of the motherboard become considerably smaller.

When the fibre sheet is used, different types of cables are not required, and therefore the risk of faulty couplings on the motherboard is eliminated. The use of the fibre sheet enables the size of the motherboard to be reduced. Furthermore, the fibre sheet is suitable for use in a wide range of temperatures. Since the structure of the fibre sheet differs widely from that of the cables, for example, the insulation material no longer becomes cracked at low temperatures. The use of a single fibre or a fibre sheet is also much more cost-effective than the use of the cables.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention will be described in more detail by means of preferred embodiments with reference to the accompanying drawings, in which

Figure 1 shows base stations of a radio system, applying the method of the invention,

Figure 2 shows a motherboard structure arranged in the base station and having printed circuit board units coupled thereto,

Figure 3 shows the motherboard structure in more detail,

Figure 4 shows an optical fibre sheet,

Figure 5 shows a motherboard having optical fibres attached to its printed circuit board material.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a radio system comprising base stations 100, 101, 102 and a subscriber terminal 200. The base stations are interconnected with one another through a cable 80. When establishing a connection to another subscriber terminal, the subscriber terminal 200 transmits a connection-establishing signal first to the base station 102, for example, which transmits the connection-establishing signal further along the cable 80 to the base station 101, for example, through which the signal can be transmitted further to the desired subscriber station.

Figure 2 shows a base station 100 comprising a motherboard structure 50. In addition, the base station comprises printed circuit board units 10, 11, 12 coupled to the motherboard structure. The units may be baseband units or interface units, for example. It is typical that each unit 10, 11, 12 carries out the task predetermined for the unit in question. The motherboard 50 acts as some kind of bus between the units attached to the motherboard. While carrying out their tasks, the different units forward a signal they have processed, for example, to another unit that is also coupled to the same motherboard 50. The units coupled to the same motherboard transmit a signal to one another through the motherboard structure.

It can be seen from the figure that the motherboard comprises a signal path 61 which at least partly connects the units 10 and 11. In addition, the motherboard comprises a signal path 62 which connects the units 11 and 12. In practice, the signal paths 61, 62 are implemented by optical connections, which enables interference on the signal path to be reduced.

Figure 3 shows the motherboard structure 50 in more detail. The motherboard structure comprises an optical fibre sheet 40 having optical fibres 41, 42 arranged therein. The optical fibres in the fibre sheet form the above signal paths 61, 62. In addition, the motherboard structure comprises first converter means 20, 21 and second converter means 30, 31. The first and the second converter means are preferably located on the motherboard. The converter means can be implemented by prior art components by lasers, for example.

The first converter means 20, 21 receive electrical low-power and high-frequency signals from printed circuit board units. The above signals include clock signals and RF signals, for example. It can be seen from the figure that the first converter means 20 convert the electrical signal received from the unit 12 into an optical signal which is conducted into an optical fibre in the fibre sheet. Next, the optical signal is applied from the fibre sheet to the second converter means 30 which converts the optical signal into an electrical signal which is applied to the unit 11 after the conversion.

If the unit 11 needs to transmit high-frequency clock signals to the unit 12, the electrical clock signal is converted into an optical signal in the first converter means 21. Next, the optical signal is applied in the fibre 42 of the fibre sheet 40 to the second converter means 31. The second converter

means 31 converts the optical signal transmitted by the first converter means into an electrical signal which is applied to the unit 12.

5 The first converter means 20, 21 convert the clock signals arriving from the printed circuit board units and having a frequency higher than 2 MHz into an optical signal. It is not necessary to convert signals having a frequency lower than 2 MHz into an optical signal, providing that the signals do not cause interference. In addition, the RF signals transmitted between the units are applied to the first converter means 20, 21. The converter means convert the signals having a power lower than 2 mW into optical signals.

10 The optical fibre sheet is preferably made of a flexible and thin material which remains unbreakable over a wide range of temperatures. The fibres of the fibre sheet are inside the fibre sheet, and therefore it is possible to reduce mechanical wear of the fibres, if any. The fibres can be placed in the fibre sheet side by side, for example. The fibre sheet can be attached on the surface of the motherboard with glue, for example. The converter means are placed on the motherboard in such a way that a signal which is supplied by the unit and passes from the converter means to the unit moves a shortest possible distance on the motherboard as an electrical signal. This makes it possible to further reduce the generation of interference.

20 The units communicating with the motherboard 50 typically have the same earth potential as the motherboard. This means that the use of the fibre sheet 40 in no way affects the earth potential of the units or the motherboard, but the signals which are converted from an electrical signal into an optical signal and the signals which are converted from an optical signal into an electrical signal have the same ground plane. Signals which have a higher power than 2 mW and earthing are conducted on the motherboard elsewhere than in the fibre sheet. The fibre sheet 40 can also be provided with an electrically conductive signal path through which a ground plane, for example, can be conducted to the desired destination.

30 As mentioned above, two or more base stations can be connected by the cable 80, preferably an optical cable. The cable 80 can be directly connected to a fibre of the fibre sheet 40. In that case the optical signal is converted into an electrical signal not until at a remote base station.

35 Figure 4 shows an optical fibre sheet 40. Figure 4 shows that the fibre sheet comprises several fibres 41, 42 which act as transmission paths for signals. Since the transmission paths in the fibre sheet 40 are not placed in-

side a thick insulating layer, an extremely large number of fibres can be disposed in one fibre sheet 40. The fibres are placed in a parallel direction in the fibre sheet, which enables as many fibres as possible to be placed in the fibre sheet 40. In the fibre sheet, not all fibres are of equal length, but some fibres
5 extend to fibre sheet extensions 45. The signals can be transmitted as far as possible by means of the fibre sheet extensions 45, which enables interference to be reduced further.

Figure 5 shows a motherboard 50 having optical fibres 41, 42 attached to its printed circuit board material. The optical fibres can be directly
10 attached to the printed circuit board material of the motherboard with glue, for example. When the number of fibres is relatively small, the fibres can be directly attached on the surface of the motherboard as shown in Figure 5. In that case the fibres attached to the printed circuit board material are apart from the fibre sheet. In other words, some of the fibres used on the motherboard can be
15 placed in the optical fibre sheet and some can be directly attached to the motherboard. It is also possible to place the fibres between the layers of the printed circuit board.

Although the invention is described above with reference to the example according to the attached drawings, it is obvious that the invention is
20 not restricted thereto, but it can be modified in many ways within the scope of the inventive idea disclosed in the attached claims.

CLAIMS

1. A signal transmission method used in a base station (100) of a radio system, for example, the base station being composed of a motherboard structure (50) and printed circuit board units (10-11) transmitting signals to one another, **characterized** by
- 5 when the printed circuit board units (10-11) of the base station communicate with one another by signals which are transmitted through the common motherboard structure (50), of these signals converting into optical signals those with a low power and a high frequency, such as clock signals and RF signals, and conducting each optical signal into an optical fibre of its own, each optical fibre being placed inside a fibre sheet (40) attached to the motherboard structure,
- 10 converting the optical signals that have propagated in the fibre sheet (40) back into electrical signals and conducting each signal that has been converted into an electrical signal to the printed circuit board unit.
- 15 2. A method as claimed in claim 1, **characterized** by transmitting signals on the motherboard by means of the optical fibres attached to a printed circuit board material of the motherboard, the optical fibres being apart from the fibre sheet (40).
- 20 3. A method as claimed in claim 1, **characterized** by converting the clock signals having a frequency higher than 2 MHz into optical signals.
4. A method as claimed in claim 1, **characterized** by converting the signals having a power lower than 2 mW into optical signals.
- 25 5. A method as claimed in claim 1, **characterized** by connecting the signals to be converted from electrical signals into optical signals and the signals to be converted from optical signals into electrical signals to the same ground plane.
6. A method as claimed in claim 1, **characterized** by converting an electrical signal into an optical signal as close as possible to the unit that has transmitted the signal.
- 30 7. A method as claimed in claim 1, **characterized** by converting an optical signal into an electrical signal as close as possible to the unit that receives the signal that has been converted into an electrical signal.

8. A method as claimed in claim 1, **characterized** by carrying out the conversion of the signal into an optical signal and an electrical signal on the motherboard.

5 9. A method as claimed in claim 1, **characterized** by transmitting the optical signal which has propagated in the fibre sheet (40) into an optical cable (80) communicating with a fibre of the fibre sheet, the cable being used for transmitting the optical signal to a different base station.

10 10. A motherboard structure (50) used in a base station of a radio system, for example, and comprises printed circuit board units (10-12) communicating with the motherboard structure, the printed circuit board units communicating with one another by signals, **characterized** in that the motherboard structure (50) comprises an optical fibre sheet (40) with optical fibres (41, 42) arranged therein,

15 first converter means (20, 21) receiving from the printed circuit board units electrical low-power and high-frequency signals, such as clock signals and RF signals, and converting the received signals into optical signals, each optical signal being conducted into an optical fibre of its own in the fibre sheet (40), and

20 second converter means (30, 31) converting the optical signals that have propagated in the fibre sheet (40) back into electrical signals which are conducted to the printed circuit board units after the conversion.

25 11. A motherboard structure as claimed in claim 10, **characterized** in that the motherboard structure comprises optical fibres in the printed circuit board material of the motherboard, the fibres being apart from the fibre sheet (40).

12. A motherboard structure as claimed in claim 10, **characterized** in that the first converter means (20, 21) convert clock signals which arrive from the printed circuit board units and have a frequency higher than 2 MHz into optical signals.

30 13. A motherboard structure as claimed in claim 10, **characterized** in that the first converter means (20, 21) convert signals having a power lower than 2 mW into optical signals.

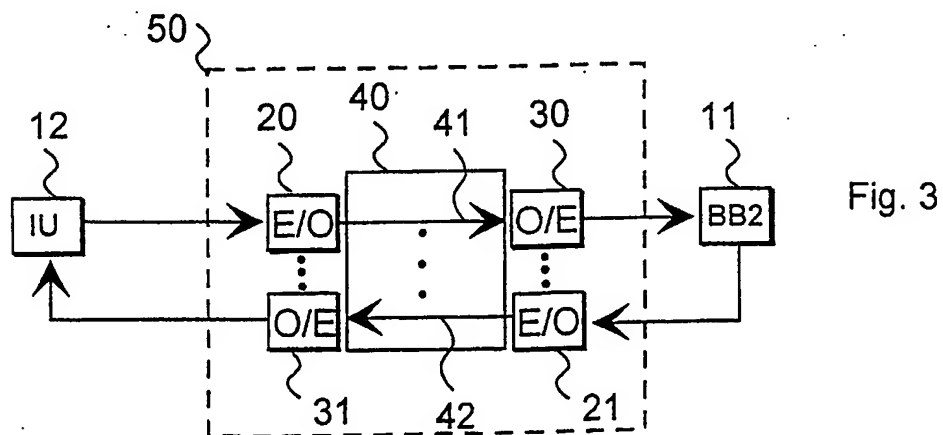
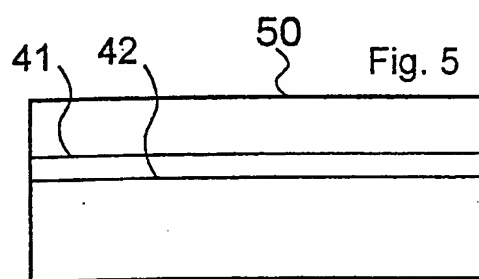
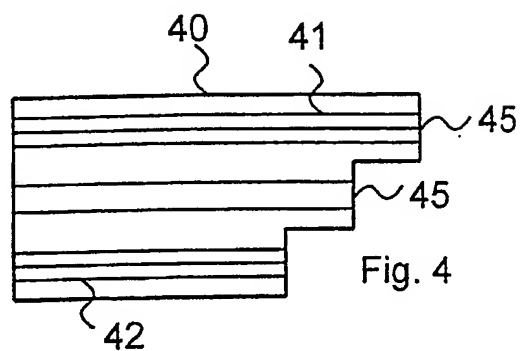
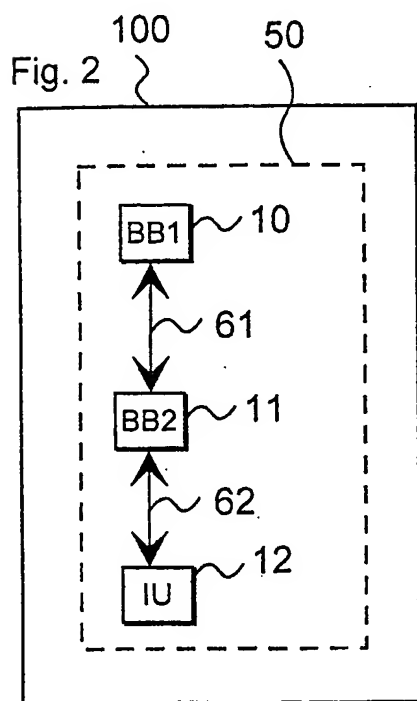
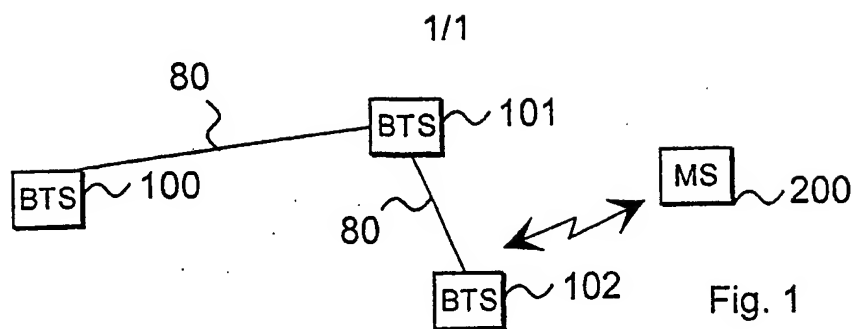
14. A motherboard structure as claimed in claim 10, **characterized** in that the first converter means (20, 21) are located as close as possible to the unit that has transmitted an electrical signal.

35

15. A motherboard structure as claimed in claim 10, **characterized** in that the second converter means (30, 31) are located as close as possible to the unit that receives the signal that has been converted into an electrical signal.

5 16. A motherboard structure as claimed in claim 10, **characterized** in that the signals to be converted from an electrical signal into an optical signal and the signals to be converted into an optical signal into an electrical signal have the same ground plane.

10 17. A motherboard structure as claimed in claim 10, **characterized** in that the motherboard structure comprises an optical cable (80) communicating with the fibre sheet (40), the optical cable transmitting the optical signal that has propagated in the fibre sheet (40) to a different base station.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 99/00389

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04B 10/12, G06F 1/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04B, G06F, G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5408567 A (PHILLIP G.B. HAMILTON), 18 April 1995 (18.04.95), see whole document --	1-2,10-11
Y	US 4836107 A (BERNHARD LANG ET AL), 6 June 1989 (06.06.89), column 1, line 14 - line 35; column 2, line 1 - line 68 --	1-2,10-11
A	US 5296748 A (DENTON G. WICKLUND ET AL), 22 March 1994 (22.03.94), column 2, line 31 - column 3, line 39; column 4, line 21 - line 32 --	1-17

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:	"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document but published on or after the international filing date	"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

28 July 1999

Date of mailing of the international search report

12 -08- 1999

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Göran Magnusson/MN
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 99/00389**C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0476569 A2 (NEC CORPORATION), 25 March 1992 (25.03.92), figure 1, abstract --	9,17
A	GB 2257260 A (GEC-MARCONI LIMITED), 6 January 1993 (06.01.93), column 4, line 6 - column 6, line 12 -- -----	1-17

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/FI 99/00389

Patent document cited in search report			Publication date	Patent family member(s)	Publication date
US	5408567	A	18/04/95	GB 2273817 A,B	29/06/94
				JP 6258544 A	16/09/94
US	4836107	A	06/06/89	DE 3640099 A,C	01/06/88
				FR 2607346 A	27/05/88
				GB 2199714 A,B	13/07/88
US	5296748	A	22/03/94	NONE	
EP	0476569	A2	25/03/92	CA 2051496 A,C	18/03/92
				DE 69123674 D,T	17/04/97
				JP 2596201 B	02/04/97
				JP 4124919 A	24/04/92
				US 5400391 A	21/03/95
				JP 4127622 A	28/04/92
GB	2257260	A	06/01/93	NONE	